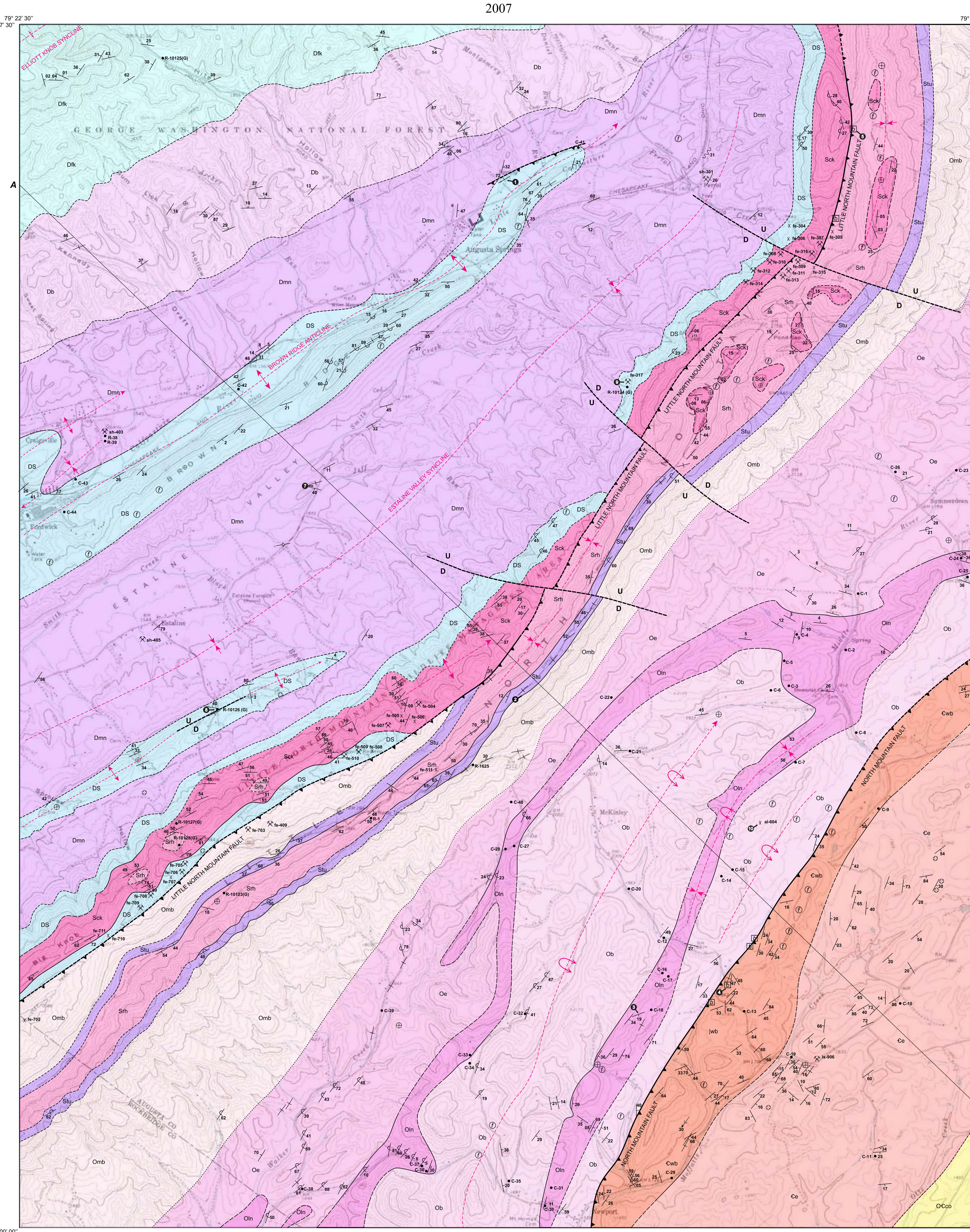
Virginia Department of Mines, Minerals and Energy

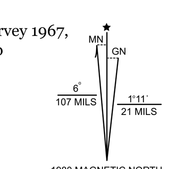
OPEN-FILE REPORT 08-01
Bedrock Geologic Map of the Augusta Springs Quadrangle, Virginia
Virginia Division of Geology and Mineral Resources

BEDROCK GEOLOGIC MAP OF THE AUGUSTA SPRINGS QUADRANGLE, VIRGINIA

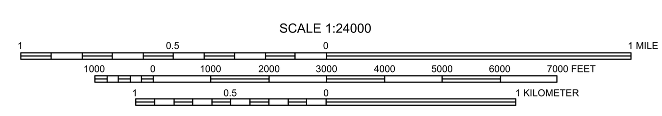
LORRIE V. COINER AND GERALD P. WILKES
2007



Basemap, scanned image (300 dpi) of U.S. Geological Survey 1967,
Revised 1978, Augusta Springs, Virginia topographic map
Universal Transverse Mercator- zone 17
Polyconic projection. 1927 North American Datum
Digital Cartography by Lorrie V. Coiner

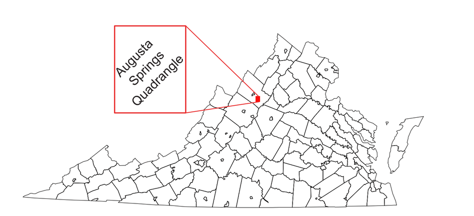


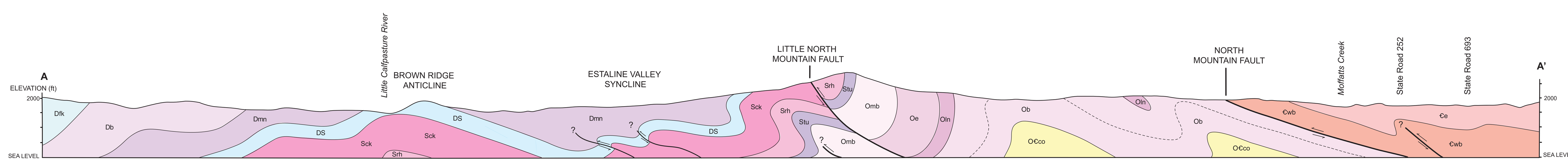
1980 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET
ANNUAL VARIATION 0 ° 1' W



CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology mapped from July 2006 to June 2007





Interpretive cross-section:
1. No vertical exaggeration
2. Subsurface structures interpreted from surface measurements

DESCRIPTION OF MAP UNITS

Dfk — **Foreknobs Formation** - Green and greenish-gray, thin- to thick-bedded, fossiliferous (most notably large crinoid stems) quartz sandstone and shale and minor quartz-pebble conglomerate. Only the lowest part of the Foreknobs is exposed in the quadrangle.

Db — **Brallier Formation** - Olive-gray, thin-bedded, micaceous, sparsely fossiliferous siltstone, shale, and thin lithic sandstone. Thickness: 1500 to 2200 feet. Conformable with the overlying Foreknobs Formation.

Dmn — **Millboro Shale and Needmore Formation, undivided** - Millboro Shale: black, fissile shale, with thin bentonite beds. Near the base is an interval of dark-gray, aphanic, thin-bedded limestone (Purcell Member?). Needmore Formation: olive-gray, weathered, fossiliferous shale, with thin bentonite beds. Composite thickness 800 to 1200 feet. Conformable with the overlying Brallier Formation.

DS — **Devonian and Silurian rocks, undivided** - Ridgeley Sandstone: medium-gray, fine- to coarse-grained, medium- to thick-bedded, calcareously cemented, fossiliferous (most notably "Spirifer" brachiopods) quartz sandstone. Helderberg Group, including Licking Creek Limestone: medium-gray, sandy, thick-bedded limestone with abundant white chert (Figure 1). New Creek Limestone: gray to pink, coarse-grained, medium- to thick-bedded, crinoidal limestone. Keyser Formation: medium-gray, coarse-grained, thick-bedded, nodular- weathering limestone. Tonoloway Limestone: dark-gray, fine-grained, thin-bedded, argillaceous limestone. Thickness of Devonian-Silurian unit is from 255 to 820 feet. Unconformable with the overlying Needmore Formation.

Sck — **Cayugan Group and Keefer Sandstone** - Cayugan Group includes rock units that have interfingering facies relationships. Wills Creek Formation: yellow-weathering, silty shale. Williamsport Sandstone: greenish-gray, medium- to coarse-grained, medium- to thick-bedded, indurated quartz sandstone, with minor siltstone beds. McKenzie Formation: calcareous, crossbedded sandstone, interbedded with medium- to dark-gray, medium- to thick-bedded, knobby-weathering limestone. Map unit also includes the Bloomsburg Formation: maroon and light-gray, fine-grained, medium-bedded quartz sandstone (locally referred to as "Leopard Rock" due to mottling on bedding surfaces), red and tan mudstone. Keefer Sandstone: white to light-gray, medium- to coarse-grained, thick-bedded, ledge-forming quartz sandstone, quartzitic in places. Thickness of the Cayugan Group and Keefer Sandstone is 150 to 800 feet. Conformable with the overlying Tonoloway Limestone.

Srh — **Rose Hill Formation** - Maroon, medium-grained, thin- to thick-bedded, hematitic, indurated quartz sandstone, and red, green, and gray shale and siltstone. Thickness: 200 to 800 feet. Conformable with the overlying Keefer Sandstone.

Stu — **Tuscarora Formation** - White to light-gray, medium- to coarse-grained, thick-bedded, ledge-forming quartz sandstone and quartzite (Figure 2), with quartz-pebble conglomerate ("jelly beans") in lower half of unit. Thickness: 50 to 260 feet. Conformable with the overlying Rose Hill Formation.

Omb — **Martinsburg Formation** - Upper unit: light- to medium-gray, fine-grained, thin-bedded sandstone, siltstone, and shale, distinctive Orthorhynchula zone near top of unit. Lower unit: light-gray, argillaceous, massive- to thin-bedded limestone. Up to 1600 feet thick. Unconformable with the overlying Tuscarora Sandstone.

Oe — **Edinburg Formation** - Liberty Hall facies: black to dark-gray, aphanic, medium- to thick-bedded limestone, with thin black shale interbeds. Lantz Mill facies: black, medium- to coarse-grained, thick-bedded, nodular limestone. Thickness: 800 to 1250 feet. Graded contact with the overlying Martinsburg Formation.

Oln — **Lincolnshire Limestone and New Market Limestone** - Lincolnshire Limestone: dark-gray, fine- to coarse-grained, thick-bedded limestone, with black chert (Figure 3). New Market Limestone: light-gray, aphanic, thick-bedded limestone. Composite thickness 100 to 435 feet. Conformable with the overlying Edinburg Formation.

Ob — **Beekmantown Formation** - Light- to medium-gray, fine-grained, thick-bedded dolostone. Distinctive "butcher-block" jointing on weathered bedding surfaces, bedded black chert, beds of white massive chert near top of unit. Some interbeds of light- to medium-gray, medium-bedded limestone. Thickness: 1500 to 2000 feet. Unconformable with the overlying New Market Limestone.

O€co — **Conococheague Formation** - Medium-gray, fine-grained, thin- to thick-bedded limestone. Some interbeds of light-gray, fine- to medium-grained, medium-bedded dolostone, and calcareously cemented, fine- to medium-grained, medium-bedded quartz sandstone. Silty laminae in the Conococheague stand out in relief on weathered surfaces. Thickness: 2000 to 2500 feet. Conformable with the overlying Beekmantown Formation.

€e — **Elbrook Formation** - Light- to dark-gray, fine- to medium-grained, thin-bedded dolostone and limestone, and pink and green shale. Thickness: 1325 to 2300 feet. Conformable with the overlying Conococheague Formation.

€wb — **Waynesboro Formation** - Maroon, green, and gray shale, interbedded with medium-gray, fine-grained limestone with minor black chert nodules, and light- to dark-gray, fine- to coarse-grained, calcareous dolostone. Only the upper part of the Waynesboro is exposed in the quadrangle. Conformable with the overlying Elbrook Formation.

MAP SYMBOLS

For all contact, fault and fold symbols: lines are solid where the location is exact, long-dashed where the location is approximate, short-dashed where the location is inferred; dotted where the location is concealed. Queries added where identity or existence may be questionable. For geologic observation symbols, observation sites are centered on the strike bar or at the intersection point of multiple symbols.

Stratigraphic Contacts

Fault Contacts

Thrust - sawteeth on upthrown block

Normal - U - upthrown block, D - downthrown block

Folds - showing direction of plunge where appropriate

Anticline

Syncline

Overturned anticline

Overturned syncline

Geologic Observations

55 Strike and dip of inclined beds

60 Strike and dip of overturned beds

Strike of vertical beds

Horizontal bedding

78 Strike and dip of inclined foliation

06 13 Foliation-showing trend and plunge of intersection lineation (pencil cleavage)

Strike of vertical foliation

31 Strike and dip of deformed bedding

Breccia

Float

30 Direction and angle of plunge of minor anticline

Sinkhole

Mineral Resources - identification numbers are preceeded by "177-C" in the Mineral Resources of Virginia database.

fe-303 Prospect (sh=shale, fe=iron, al=aluminum)

sh-814 Active mine or quarry (ls=limestone, sh= shale)

ls-605 Abandoned mine or quarry (ls=limestone, fe= iron, sh= shale)

Geologic References

R-1001 Rock repository sample

R-1200(G) Rock repository sample with geochemical analysis

C-3000 Other geochemical analysis (C-carbonate)

2 Location and figure number of photograph

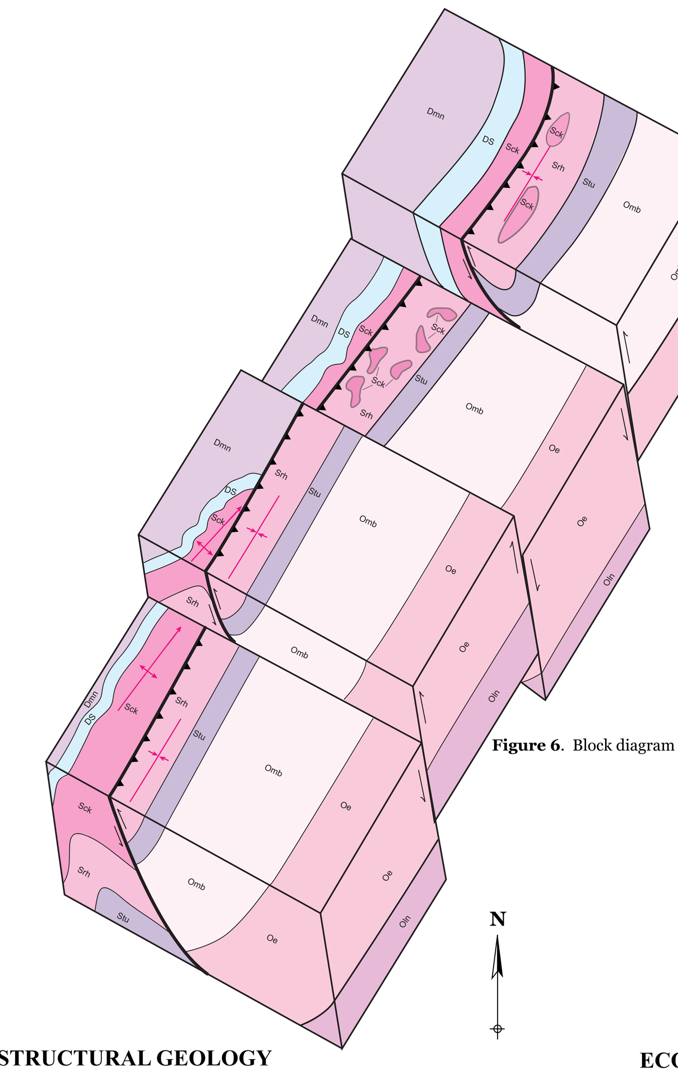


Figure 6. Block diagram of structures in the Pond Gap area (not to scale).

STRUCTURAL GEOLOGY

North Mountain fault - The North Mountain fault is a regional thrust fault that dips 20 degrees or less to the southeast within the quadrangle. Thrusting of hanging wall rock of the Cambrian Waynesboro Formation over the Ordovician Beekmantown Formation along the fault resulted in thousands of feet of displacement. Fault breccia and highly fractured rock occur in a belt up to hundreds of feet wide along the trace of the fault. The breccia can contain fragments of country rock of varying sizes (Figure 4) or have the appearance of crush conglomerate.

Little North Mountain fault - To the north of the quadrangle, the North Mountain fault splits into two fault traces. The North Mountain fault proper swings east into the Great Valley while a second fault continues south, along the west flank of Little North Mountain. This fault is herein referred to as the Little North Mountain fault. In the Augusta Springs quadrangle, this fault places Ordovician and Silurian age rock over Silurian and Devonian age rock. The Little North Mountain fault dips approximately 30 degrees or more to the southeast and has an apparent displacement of several hundred feet. Brittle deformation is evidenced by the angular fragments of brecciated rock along the fault (Figure 5). There are at least three cross faults that displace the main fault along its trace through the quadrangle. These cross faults are high-angle faults that create discrete fault blocks between them (Figure 6).

Estaline Valley syncline - Estaline Valley is underlain by Devonian Millboro Shale that is roughly in a synclinal form. The Millboro is deformed by interformational folding and faulting (Figure 7). There is one small amplitude anticline near the eastern edge of the syncline that brings the Ridgeley and Helderberg to the surface.

Brown Ridge anticline - Brown Ridge is formed by an anticline. Although there does not appear to be any section missing, the contact of the Ridgeley Sandstone and the Needmore/Millboro map unit is convoluted and the Helderberg Group has been slightly metamorphosed. The anticline plunges northeast into deformed Millboro Shale.

Elliott Knob syncline - Only a small part of the east limb of the Elliott Knob syncline is in the quadrangle. Devonian rocks dip to the northwest with minor folding and faulting (Figure 8).

ECONOMIC GEOLOGY

Limestone and dolostone - Cambrian, Ordovician, and Devonian carbonate rocks crop out in the quadrangle and have been sampled and analyzed by Giannini and Hostettler (1994). There are no active large quarries in the quadrangle, but there are small quarries that were made for local use. Potential use for these rocks include aggregate, dimension stone, and high-calcium limestone.

Shale - Devonian shales have been tested in the quadrangle for structural clay products and have been found suitable for brick and lightweight aggregate (Calver, Smith, and LeVan, 1964). An abandoned shale pit near Fordwick was operated by Lehigh Portland Cement Company in the 1950's and 60's for use in the manufacture of portland and masonry cement. One shale pit is currently intermittently active for use as road ballast within the state wildlife management area.

Iron - Iron ore was mined from small open pits in the late 1800's (Figure 9). The ore is probably associated with the Ridgeley Sandstone; it may have formed as a secondary deposit along a fault. Concentration of minable ore is limited to small areas and does not appear to be regional in extent. The ore was utilized in iron making at three furnaces in the quadrangle: Ferrol, Estaline, and a reported furnace at Pond Gap (now Augusta Springs).

Sandstone and quartzite - The Tuscarora and Keefer sandstones and possibly the Ridgeley have potential for high-silica sand and non-polishing aggregate. Testing for these commodities has not been done; however, there are several promising exposures within the quadrangle that may have the potential.

Bauxite - Prospect pits for bauxite were dug in the early 1900's on the Yago farm. Several pits, collectively called the Yago prospect, are quite large (Figure 10), and all occur within the Beekmantown Formation. There is no indication of ore on the ground.

ACKNOWLEDGEMENTS

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BIBLIOGRAPHY

Calver, J. L., Smith, C. E., and Levan, D. C., 1964, Analyses of clay, shale and related materials- west-central counties: Virginia Division of Mineral Resources Mineral Resources Report 5, 230p.

Giannini, W. F. and Hostettler, K. K., 1994, Analyses of carbonate rocks-northwestern Virginia (Elkins-Staunton 0.5° X 1° quadrangles: Virginia Division of Mineral Resources Publication 135, 160p.

Kozak, S. J., 1970, Geology of the Elliott Knob, Deerfield, Craigsville, and Augusta Springs quadrangles: Virginia Division of Mineral Resources Report of Investigations 21, 23p, 1:24,000- scale maps.

Mineral Resources of Virginia database: Virginia Division of Mineral Resources economic geology files.

Rader, E. K. and Wilkes, G. P., 2001, Geologic map of the Virginia portion of the Staunton 30- X 60- minute quadrangle: Virginia Division of Mineral Resources Publication 163, 1:100,000-scale map.

SUGGESTED REFERENCE

Portions of this publication may be quoted if credit is given to the Virginia Department of Mines, Minerals and Energy, Division of Geology and Mineral Resources. It is recommended that the reference to this report be made in the following form:

Coiner, L. V. and Wilkes, G. P., 2008, Bedrock geologic map of the Augusta Springs quadrangle, Virginia: Virginia Division of Geology and Mineral Resources, Open-File Report 08-01, 1:24,000- scale map.

Figure 1. Augusta White Sulphur Spring issues from the Licking Creek Limestone.

Figure 2. Near vertical ledge of Tuscarora sandstone on Little North Mountain. Because of the Tuscarora's resistance to weathering, it underlies the crest of the mountain in many places.

Figure 3. Chert nodules in the Lincolnshire Limestone. Nodules are diagnostic of the Lincolnshire.

Figure 4. North Mountain fault breccia. The rock consists of varying sized clasts of country rock and calcite-filled fractures.

Figure 5. Little North Mountain fault breccia. Angular to sub-angular clasts of Silurian sandstone indicate the brittle nature of the faulted rock.

Figure 7. Northwest-verging chevron fold in an outcrop of Millboro Shale on Route 601 in the Estaline Valley southeast of the Brown Ridge fault.

Figure 8. Deformed Devonian-Silurian rock within the Estaline Valley syncline. Field of view is approximately 8-by-15 feet.

Figure 9. Iron ore outcrop in mine near the Pond Gap Road. The large angular clast of country rock (C) that is surrounded by limonite is about 1 foot across. This and other iron mines contained ore that was pod-like and was extracted by open pit methods. The ore was processed into pig iron at nearby furnaces.

Figure 10. Largest of the Yago farm prospect pits. Prospectors sought aluminum ore in the Great Valley during the 1940's.